
(12) PATENT ABRIDGMENT (11) Document No. AU-B-24281/88
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 609201

(54) Title
DOUBLE DRUM WASHING MACHINE

International Patent Classification(s)
(51)⁴ **D06F 031/00 D06F 023/02**

(21) Application No. : **24281/88**

(22) Application Date : **27.07.88**

(87) WIPO Number : **WO89/01069**

(30) Priority Data

(31) Number	(32) Date	(33) Country
077889	27.07.87	US UNITED STATES OF AMERICA

(43) Publication Date : **01.03.89**

(44) Publication Date of Accepted Application : **26.04.91**

(71) Applicant(s)
M. BRENT KEITH

(72) Inventor(s)
M. BRENT KEITH

(74) Attorney or Agent
F B RICE & CO, 28A Montague Street, BALMAIN NSW 2041

(56) Prior Art Documents
US 4674691

(57) Claim

1. A drum washing machine comprising:

an outer cylindrical chamber member having a longitudinal axis;

an inner cylindrical chamber member within said outer chamber member and spaced therefrom;

means for maintaining said inner and outer chamber members in spaced relationship, said means comprising a first conveyor member extending between said inner and outer chamber members;

a second conveyor member mounted within said inner cylindrical chamber member;

said first conveyor member comprising a first longitudinally extending helix having a first pitch;

said second conveyor member comprising a second longitudinally extending helix having a second pitch with said second pitch being opposite in direction from said first pitch;

said first helix dividing the space between said

(11) AU-B-24281/88
(10) 609201

-2-

inner and outer chamber members into a plurality of outer compartments for containing wash water and said second helix dividing the space defined by said inner cylindrical chamber member into a plurality of inner compartments for containing laundry, said inner and outer compartments defining areas of overlap on said inner cylindrical chamber member; and

said inner cylindrical chamber member having perforations formed within the areas of overlap so that fluid interchange is established between each inner compartment and the corresponding overlapping outer compartment.



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁴ : D06F 31/00	A1	(11) International Publication Number: WO 89/01069 (43) International Publication Date: 9 February 1989 (09.02.89)
---	----	---

(21) International Application Number: PCT/US88/02557

(22) International Filing Date: 27 July 1988 (27.07.88)

(31) Priority Application Number: 077,889

(32) Priority Date: 27 July 1987 (27.07.87)

(33) Priority Country: US

(71)(72) Applicant and Inventor: KEITH, M., Brent [US/US];
Route 3, Box 185K, Jasper, GA 30143 (US).(74) Agent: KERR, Steven, D.; Thomas & Kennedy, 100
Galleria Parkway, Suite 590, Atlanta, GA 30339 (US).(81) Designated States: AT (European patent), AU, BE (Eu-
ropean patent), CH (European patent), DE (European
patent), FR (European patent), GB (European pa-
tent), IT (European patent), JP, LU (European pa-
tent), NL (European patent), SE (European patent).

Published

*With international search report.**Before the expiration of the time limit for amending the
claims and to be republished in the event of the receipt
of amendments.*

A.O.J.P. 20 APR 1989

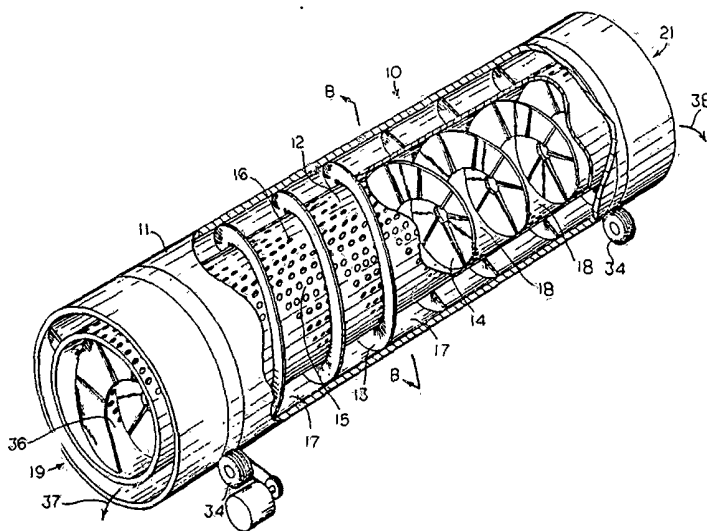
AUSTRALIAN

- 1 MAR 1989

PATENT OFFICE

amendments
and is correct for
printing

(54) Title: DOUBLE DRUM BATCH WASHING MACHINE



(57) Abstract

A double drum batch washing machine (10) comprises an inner cylinder (12), an outer cylinder (11), an inner helical transfer screw (14) within the inner cylinder (12) and an outer helical transfer screw (13) within the space between the inner (12) and outer cylinders (11). The inner helical transfer screw (14) has a pitch in one direction and the outer helical transfer screw (13) has a pitch in the other direction so that the compartments (17, 18) formed by the transfer screws (13, 14) within the inner cylinder (12) and the space between the inner (12) and outer cylinders (11) define areas of overlap on the surface of the inner cylinder (12). The areas of overlap have holes formed therein so that fluid interchange is established between each outer compartment (17) and only the corresponding overlapping inner compartment (18). Laundry (44) is placed in the inner compartments (18) and wash water is placed in the outer compartments (17) such that it communicates with the inner compartments (18) and the laundry (44) contained therein. Laundry (44) is washed by oscillating the washing machine (10) through a predetermined angular arc. When the washing machine (10) is rotated through a complete circle, laundry (44) is transferred in one direction by the inner helical transfer screw (14) and wash water (43) is transferred in the opposite direction by the outer transfer screw (13).

-1-

DOUBLE DRUM BATCH WASHING MACHINE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to laundry washing machines and more particularly to industrial washing machines.

Description of the Prior Art

Industrial laundry washing machines having multiple washing compartments have been available for some time. Many of these machines comprise a horizontally mounted generally cylindrical chamber having a conveyor worm or auger screw rigidly mounted in the interior of the chamber so that several washing compartments are defined between the surfaces of the auger screw. Laundry to be washed in these machines is typically placed in the first compartment on one end of the machine and wash water containing proper detergents or other treating chemicals is introduced into the compartments. Introduction of wash water is typically achieved either by spraying it into the compartment from perforations formed in the hub of the auger screw or by continuously supplying wash water from one end of the chamber and allowing it to

-2-

- flow through perforations formed in the transfer screw walls and out the opposite end of the chamber.

With laundry and wash water in the compartment, the machine will generally be oscillated through a predetermined angular range several times which agitates the laundry in the wash water. At the end of this oscillation period, the machine will be rotated through a 360° arc which transfers the laundry to the next compartment in the chamber where it is again oscillated with wash or rinse water. This process is repeated until the laundry reaches the last compartment where it is removed from the machine.

Washing machines of the type described above are known in the laundry industry as mono-shell or single drum machines, examples of which are illustrated and disclosed in U.S. patents of Stoll et al (4,210,004) and Schmidt et al (4,494,265).

Another prior art washing machine design known as a double drum machine comprises several individual cylindrical inner washing drums connected together in series with passageways along their longitudinal axes. These inner drums are rotatable within fixed outer drums which contain wash water or other chemicals. Laundry to be washed is transferred to each inner drum in turn where wash water or other treating chemicals within the fixed outer drum enter through holes in the inner drum. The drum is then oscillated or rotated within the fixed outer drum to affect washing. At the end of each wash cycle, the laundry is transferred through the passageway to the next inner drum for the next wash cycle. This process is repeated for each washing drum until the laundry is clean. This type of machine is disclosed in U.S. patents to Pellerin et al (4,485,509), Harrsch

35

-3-

- (4,156,358), Hugenbrunch (4,109,493) and Bhaysar (Re. 30,214).

5 The prior art washing machines exhibit several shortcomings in operation. In the continuous flow wash water machines, water intermixes between chambers so that batches of cloths of different colors cannot be washed in the machine at the same time. In addition, large volumes of water are required to maintain the flow of the wash water through the machine and complicated valve and pipe systems are required to introduce detergent and other treating liquids into the wash water flow.

10 Machines with nonperforated auger screw walls in which wash water and other treatments are introduced into each chamber through a pipe extending along the axis of the screw also require complicated drain systems to remove the water from each compartement at the end of each wash cycle so that it will not be transferred with the cloths to the next washing compartment. In these as well as other prior art designs, dirt and heavy soil material washed from the laundry is often transferred with the laundry to the next compartment because it is too large to drain through the drain system with the water.

25 Prior art machines comprising series of individual inner washing drums rotatable within fixed outer drums tend to be even more complicated than continuous flow machines. Because of the individual compartments, complicated means of delivering wash water to each drum and draining it therefrom at the end of a wash cycle is required. These machines use a large quantity of water and often have a pluraltiy of valves and flow pipes to clog.

35

SUMMARY OF THE INVENTION

The present invention is an improved apparatus and method for treating industrial laundry that overcomes the disadvantages of prior art washing machines.

5 The present invention comprises a drum washing machine comprising:

 an outer cylindrical chamber member having a longitudinal axis;

 an inner cylindrical chamber member within said outer
10 chamber member and spaced therefrom;

 means for maintaining said inner and outer chamber members in spaced relationship, said means comprising a first conveyor member extending between said inner and outer chamber members;

15 a second conveyor member mounted within said inner cylindrical chamber member;

 said first conveyor member comprising a first longitudinally extending helix having a first pitch;

 said second conveyor member comprising a second
20 longitudinally extending helix having a second pitch with said second pitch being opposite in direction from said first pitch;

 said first helix dividing the space between said inner and outer chamber members into a plurality of outer
25 compartments for containing wash water and said second helix dividing the space defined by said inner cylindrical chamber member into a plurality of inner compartments for containing laundry, said inner and outer compartments defining areas of overlap on said inner cylindrical
30 chamber member; and

 said inner cylindrical chamber member having perforations formed within the areas of overlap so that fluid interchange is established between each inner compartment and the corresponding overlapping outer
35 compartment.



The space between the inner and outer chambers contains a generally helical transfer screw or auger screw that divides the space into several compartments for containing wash water and transferring it from one end of the machine to the other upon rotation of the machine. 5 The inner chamber also contains a generally helical transfer screw rigidly attached along its outer periphery to the inside of the inner chamber and dividing the inner chamber into several compartments for containing laundry and transferring laundry from one end of the machine to 10 the other upon rotation of the machine. The inner transfer screw has a pitch angle that is substantially the same as the pitch angle of the outer screw but in the opposite direction so that as the washing machine is 15 rotated, wash water or other treating material is transferred by the outer screw in one direction while the laundry or other textile to be treated is transferred in the other direction by the inner screw.

The compartments formed in the space between the 20 outer and inner chambers by the outer screw define areas of overlap on the periphery of the inner chamber with the compartments formed on the inside of the inner chamber. These areas of overlap on the inner chamber have perforations formed therein so that wash water in one of 25 the outer compartments can flow only into the corresponding overlapping inner compartment and mix with the laundry therein. Thus the wash water



-5-

does not intermix between wash compartments during washing. As the machine rotates during a transfer cycle, the wash water contained in only the last outer compartment is dumped out of the machine by the outside conveyor helix. Some water is also transferred out of the machine with the wet laundry. Only this amount of water expelled at one end by the outer helix plus the small amount that remains in the clothes need be added to the machine each cycle to maintain a full wash water level. No complicated wash water inlet and drain system is required. Wash water is simply supplied to the first outside compartment on one end of the machine and it is conveyed to succeeding compartments by the outside helix upon each transfer rotation of the machine and finally out of the machine on the opposite end. In addition, dirt and other material from heavy soils in the laundry falls through the perforations in the inner chamber to the corresponding outer chamber where it is transferred out of the machine with the wash water rather than being transferred with the laundry.

Other objects, features and advantages of the present invention will become apparent upon reading the following specification, when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cutaway view of a typical prior art washing machine.

Fig. 2 is a perspective view of the invention with cutaway sections showing the inner and outer transfer helices.

Fig. 3 is a side elevation cutaway view of the invention showing the inner and outer compartments and the perforations in the inner chamber.

-6-

5 Figs. 4a through 4d are cutaway end elevations along line AA of Fig. 3 showing one embodiment of the invention in various stages of the wash and transfer cycles of the machine.

DETAILED DESCRIPTION

10 Referring now in more detail to the drawings, in which like numerals indicate like parts throughout the several views, Fig. 1 illustrates a typical prior art tunnel batch washing machine 25. It comprises an outer cylindrical chamber 26 which has rigidly mounted therein a transfer screw or auger or worm 27 which divides the interior of the chamber into a plurality of compartments 28, 28. The transfer screw has
15 mounted along its longitudinal axis a wash water supply pipe 32 having perforations 29 formed along its length within each of the compartments 28 formed by the transfer screw 27. The introduction of wash water into the compartments is controlled by a control valve system 33 and wash water is drained from each
20 compartment after a wash cycle through drain valves 31.

25 Fig. 2 is a cutaway perspective view of the present invention showing the double drum batch washing machine generally indicated by the numeral 10. The washing machine 10 has an outer generally cylindrical chamber 11 for containing wash water or other treating media. Outer chamber 11 is mounted for rotation about its longitudinal axis on roller means 34. Drive means is connected to the washer for
30 oscillating it through a predetermined angular range to affect washing and rotating it through a complete circle to affect transfer of laundry and wash water, as will be explained hereinafter.

35

-7-

- Mounted inside the outer chamber and spaced therefrom is a generally cylindrical inner chamber 12 for containing laundry or linen to be washed or otherwise treated. In the space between the inner and outer chambers is rigidly mounted an outer transfer screw or auger or worm 13 which has a pitch from left to right in the embodiment shown in Fig. 2. Outer transfer screw 13 divides the space between the chambers into a plurality of compartments 17, 17 for containing wash water during washing. Rigidly mounted around its periphery to the inside of inner chamber 12 is an inner transfer screw or auger or worm 14. Inner transfer screw 14 has a pitch that is generally the same in degree as that of outer transfer screw 13 but in the opposite direction, running from right to left in the embodiment shown in Fig. 2. Inner transfer screw 14 divides the space defined by the inner chamber into a plurality of compartments 18 for containing laundry during washing.

As can be seen in Fig. 2, the opposite pitches of screws 13 and 14 define areas of overlap 15 on the surface of inner chamber 12. Within the areas of overlap 15 on inner chamber 12 are formed a plurality of perforations or holes 16, 16 through which wash water may flow. It can be seen from Fig. 2 that wash water contained in one of the outer compartments 17 can communicate only with the corresponding overlapping inner compartment 18 because of the placement of the perforations 16 only within the areas of overlap 15. Thus it is seen that wash water from one pair of corresponding overlapping inner and outer compartments cannot mix with wash water from adjacent pairs of compartments.

The invention as illustrated in Fig. 2 has an inlet end generally indicated by the numeral 19 and a

-8-

discharge end generally indicated by the numeral 21. In the embodiment illustrated, laundry to be washed or treated is placed in first inner compartment 36 on inlet end 19 and wash water or other treatment media is introduced into first outer compartment 39 on discharge end 21. As washing machine 10 is rotated in a counterclockwise direction as viewed from inlet end 19, it can be seen from Fig. 2 that the laundry will be transferred by inner transfer screw 14 from inlet end 19 to discharge end 21 and wash water will be transferred by the outer transfer screw 13 from discharge end 21 to inlet end 19. Although Fig. 2 illustrates a particular pitch and direction of the transfer screws and operation is discussed assuming transfer is accomplished by counterclockwise rotation, it will be understood that other degrees and directions of transfer screw pitches as well as other transfer rotation directions will work equally well.

Fig. 3 is a cutaway view of the invention taken along line BB in Fig. 2. This view shows the washing machine 10 and more clearly illustrates the definition of the areas of overlap 15 on the inner chamber 12. Perforations 16 are shown formed in the areas of overlap 15 defined by outer compartments 17 and inner compartments 18. As can be seen in Fig. 3, perforations 16, 16 are confined to the overlapping areas on chamber 12.

Figs. 4a through 4d are a series of end elevation cutaway views of the invention taken generally along line AA in Fig. 3 illustrating the operation of a preferred embodiment of the invention. These figures show the locations of the wash water and the laundry at 4 stages of the cycle of washing machine 10. Illustrated in the figures is washing machine 10 having a generally cylindrical outer chamber 11.

-9-

- Inner chamber 12 is shown mounted in and spaced from outer chamber 11 and one wall of inner transfer screw 14 and outer transfer screw 13 are shown. The particular embodiment illustrated in this series of figures shows a generally concave floor member 22 which is impervious to the wash water and that extends along the length of washing machine 10. Floor member 22 is rigidly attached along its edges 41 to the inside of outer chamber 11 such that the line of attachment is impervious to the wash water. Floor member 22 closely approaches the bottom of inner chamber 12 generally near the middle of floor member 22. A dry well 24 is defined between the convex side of the floor member and the inside wall of the outer chamber 11. Dry well 24 may be used as a space in which to house electrical connections or plumbing and may be provided with access doors or ports through the outside chamber without affecting the operation of the washing machine. Figs. 4a through 4d show cross sections of generic electrical or plumbing conduit 42.

Also shown in the embodiment of the invention illustrated in Figs. 4a through 4d is an inwardly convex ceiling member or bulge 23 formed in the top of inner chamber 12. Fig. 4a shows washing machine 10 in its normal or rest or reference position, and laundry 44 and wash water 43 are shown generally as they would be with washing machine 10 in this position. Figs. 4b and 4c show the locations of the laundry and wash water near the two extreme extents of an oscillation range. Fig. 4d shows the location of the laundry and wash water near the midpoint of a transfer rotation of washing machine 10.

-10-

OPERATION

In operation, washing machine 10 is first loaded or filled with wash water or other treating media by supplying wash water into the first compartment 39 in the space between the outer and inner chambers 12 and 11, respectively. Washing machine 10 is rotated through a complete circle in the counterclockwise direction until it is in the rest or normal position as illustrated in Fig. 4a. Sufficient wash water has been added to each compartment so that in the rest position, laundry 44 is adequately wetted by wash water 43 so that it may be properly washed. Washing machine 10 is then oscillated through a predetermined angular range for a number of cycles as shown generally in Figs. 4b and 4c. As washing machine 10 is oscillated, laundry 44 is agitated in wash water 43. Conventional ribs may be provided in the inner compartments if desired to aid in the agitation of the laundry. In addition, in the preferred embodiment illustrated in Figs. 4a through 4d, as washing machine 10 oscillates through the normal position of Fig. 4a, the wash water rests on floor member 22 where it is raised above the bottom of outer chamber 11 and flows through perforations 16 into inner compartment 18. As the oscillation continues to its extreme limits as illustrated in Figs. 4b and 4c, wash water gradually rolls off of floor member 22 until it rests on the inside wall of outer chamber 11. It is thus apparent that as washing machine 10 oscillates from extreme to extreme, wash water will be forced alternately into and out of inner compartment 18 and consequently into and out of laundry 44 contained therein. In addition, the level of the wash water is raised and lowered. This raising and lowering of wash water level in addition to the agitation of the laundry as washing

-11-

- machine 10 oscillates produces improved washing action over prior art washing machines.

At the end of a predetermined number of oscillations, it is desired to transfer the laundry to the next compartment in the inner chamber for the next wash cycle. This is accomplished by rotating washing machine 10 through a complete circle in the counterclockwise direction so that it is again in the rest position illustrated in Fig. 4a. During this rotation, the laundry is transferred by inner transfer screw 14 to the next compartment toward end 21 and wash water is transferred by transfer screw 13 to the next compartment between inner chamber 12 and outer chamber 11 toward end 19. At approximately the midpoint of the transfer rotation, the laundry rides over the ceiling member 23 as shown in Fig. 4d. This causes the laundry to be raised somewhat with respect to the wash water level so that excess wash water is drained into the outer compartment before the laundry is transferred to the next inner compartment. The wash and transfer process is repeated until the laundry has traversed the length of washing machine 10 and emerges from end 21 where it will typically be removed and transported to dryers or other treatment stations.

Several functions of the invention become apparent from the detailed description and operation set out above. The first function is the raising and lowering of the wash water level in the inner compartments during the wash cycle oscillations by virtue of floor member 22. This wash water action results in improved washing action. Another function is the raising of the laundry with respect to the wash water during a transfer rotation so that excess wash water is drained from the laundry before it is transferred to the next

-12-

— wash compartment. A function of the washing machine as described above is that during each transfer rotation, laundry is transferred one compartment in a first direction and wash water is transferred one
5 compartment in the opposite direction. Thus the wash water is transferred, not to the next laundry compartment, but to the next one thereafter. In other words, a particular batch of water contacts the
10 laundry in alternate, not adjacent, laundry compartments. The laundry, therefore, comes into contact with and is washed by only every other reservoir of wash water. This allows washing of different colors of fabric at the same time by alternating colors in the inner compartments. The
15 inner compartments might, for example, be loaded alternately with red laundry, white laundry, red laundry, etc. and the wash water that comes into contact with the red laundry will never mix with the wash water that comes into contact with the white
20 laundry, nor will it ever contact the white laundry.

The present invention is also very efficient in terms of the amount of wash water required during operation. Prior art continuous flow machines require a continuous supply of wash water flowing into the
25 laundry discharge end of the machine. Prior art multiple drum machines and tunnel type machines with impervious transfer screw walls require that the volume of wash water in each compartment be partially or completely drained and fresh wash water resupplied
30 upon completion of each wash cycle. Each of these prior art designs requires large volumes of wash water for each wash cycle.

During operation of the present invention, the volume of wash water contained in one outer
35 compartment plus a smaller amount that remains in the

-13-

- wet laundry is transferred out of the machine upon each transfer rotation. To maintain the machine fully loaded with wash water, one need only add that same volume of fresh water to the first outer compartment at the other end of the machine at the end of each transfer rotation. Detergent or other treating chemicals can be added to the water before it is placed in the machine or it can be added in a conventional manner, e.g., through a central hub. As the laundry progresses down the length of the machine, it comes into contact with fresher and fresher water, so that at the discharge end, it is rinsed by fresh water in the last compartment. Because of this unique arrangement, it is possible to perform wash and rinse cycles without having to empty the water out.

Although the invention has been described in the form of a preferred embodiment, many modifications, additions and deletions may be made thereto without departure from the spirit and scope of the invention as set forth in the claims.

25

30

35

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A drum washing machine comprising:
 - an outer cylindrical chamber member having a longitudinal axis;
 - an inner cylindrical chamber member within said outer chamber member and spaced therefrom;
 - means for maintaining said inner and outer chamber members in spaced relationship, said means comprising a first conveyor member extending between said inner and outer chamber members;
 - a second conveyor member mounted within said inner cylindrical chamber member;
 - said first conveyor member comprising a first longitudinally extending helix having a first pitch;
 - said second conveyor member comprising a second longitudinally extending helix having a second pitch with said second pitch being opposite in direction from said first pitch;
 - said first helix dividing the space between said inner and outer chamber members into a plurality of outer compartments for containing wash water and said second helix dividing the space defined by said inner cylindrical chamber member into a plurality of inner compartments for containing laundry, said inner and outer compartments defining areas of overlap on said inner cylindrical chamber member; and
 - said inner cylindrical chamber member having perforations formed within the areas of overlap so that fluid interchange is established between each inner compartment and the corresponding overlapping outer compartment.
2. A drum washing machine as claimed in claim 1 wherein said inner and outer helices are rigidly connected to said outer and inner cylindrical chamber members and said outer cylindrical chamber member is mounted for rotation about its longitudinal axis.



3. A drum washing machine as claimed in claim 2 further comprising means for raising and lowering the level of the wash water as the laundry is washed so that wash water moves into and out of the laundry.

4. A drum washing machine as claimed in claim 2 further comprising means for raising the laundry relative to the wash water so that excess wash water may be drained from the laundry.

5. A drum washing machine as claimed in claim 2 further comprising means for oscillating the washing machine through a predetermined angular range to affect washing and rotating the washing machine through a complete circle to convey laundry to the next compartment in the space defined by the inner cylindrical chamber member in one direction of travel and wash water to the next compartment in the space between said inner and outer cylindrical chamber members in a direction of travel opposite the direction of travel of the laundry.

6. A double drum batch washing machine as claimed in claim 1 substantially as hereinbefore described with reference to the accompanying drawings.

DATED this 25th day of January 1991

KEITH M. BRENT
Patent Attorneys for the
Applicant:

F.B. RICE & CO.



1/3

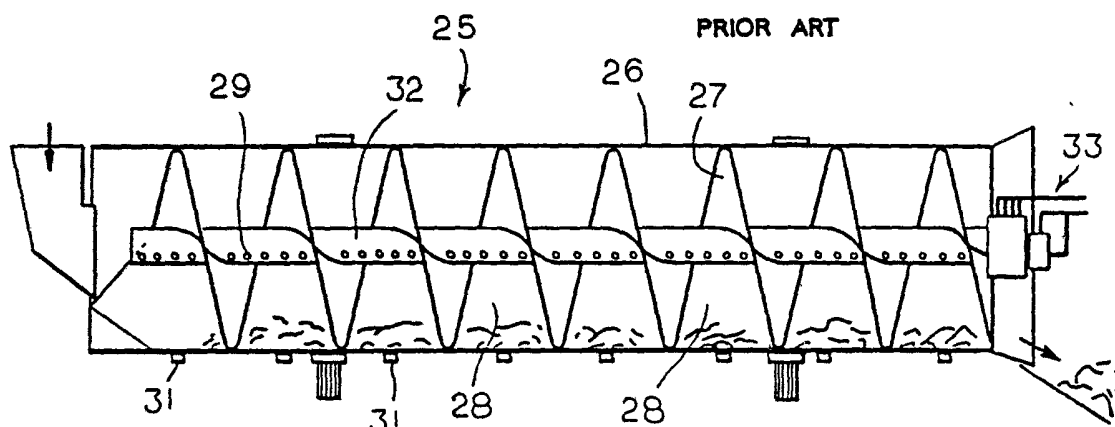


Fig 1

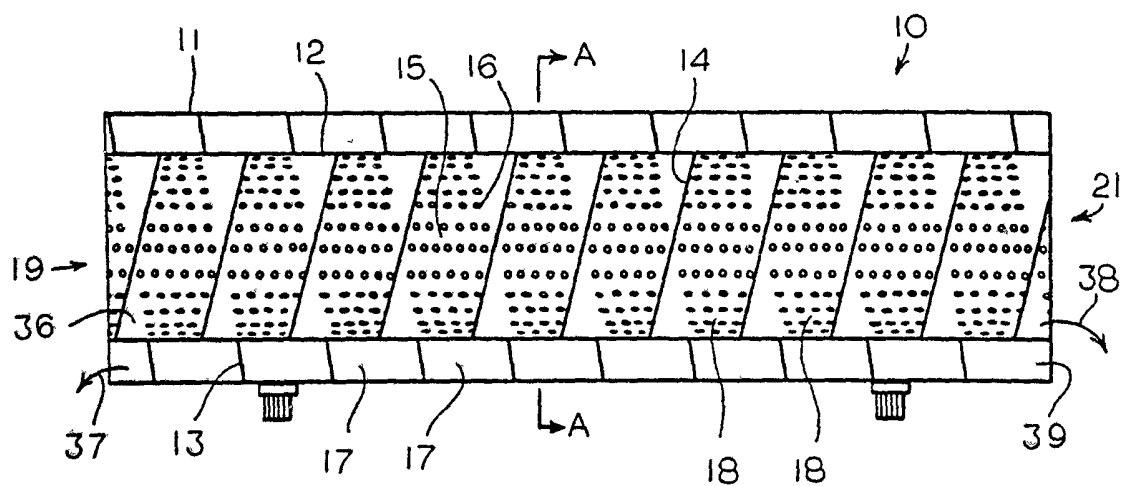
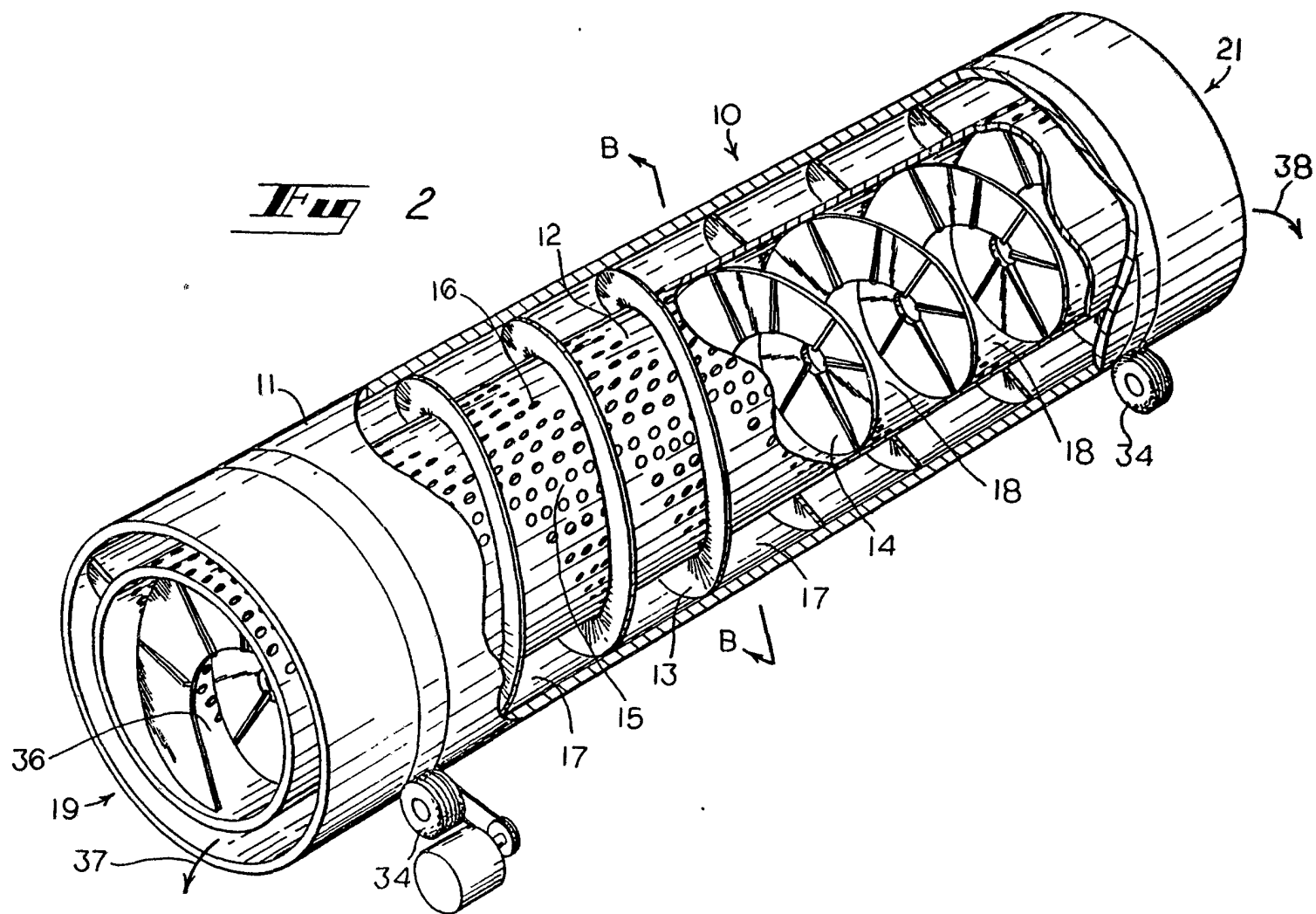


Fig 3



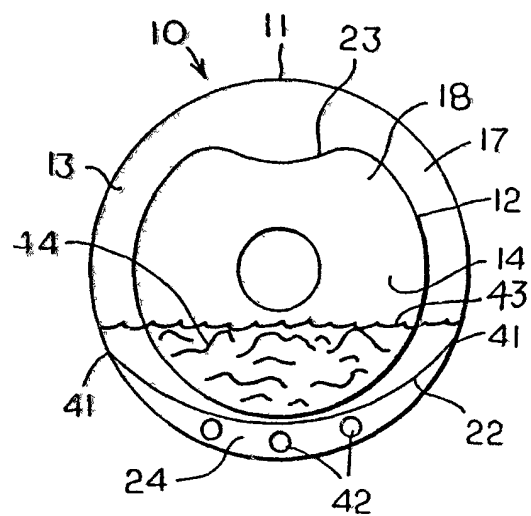


Fig 4A

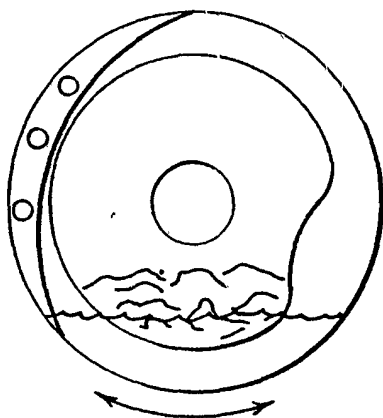


Fig 4B

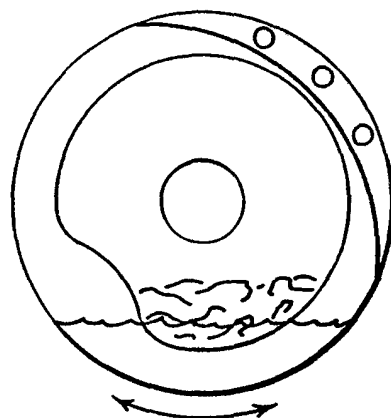


Fig 4C

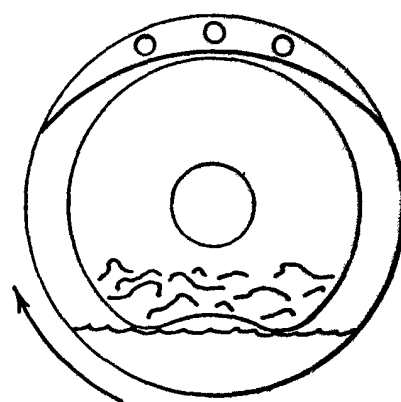


Fig 4D

INTERNATIONAL SEARCH REPORT

International Application No PCT/US88/02557

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC (4): D06F 31/00		
U.S. CL. 8/158, 159; 68/27, 58, 143, 158, 197		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
U.S.	8/158, 159; 68/27, 58, 139, 142, 143, 145, 148, 158 171, 173, 197; 134/65, 119, 120, 132, 163; 209/270;	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
U.S. 51/164.1; 99/536		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category [*]	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No ¹³
X	US,A, 4,674,691, Published 23 June 1987, (DIDION) See the entire document	1-6, 19, 20
<u>X</u> <u>Y</u>	US,A, 4,478,060, Published 23 October 1984, (GRUNEWALD) See the entire document	<u>13</u> 14, 15
<u>X</u> <u>Y</u>	US,A, 4,422,309, Published 27 December 1983, (SCHMIDT ET AL) See entire document	<u>16</u> 14, 15, 18
<u>X</u> <u>Y</u>	US,A, 3,336,768, Published 22 August 1967, (KLEEFISCH) See column 2, lines 21-27	<u>17</u> 15, 18
X	US,A, 1,253,751, Published 15 January 1918, (VAUGHAN) See entire document	16
X	GB,A, 846,654, Published 31 August 1960, (BICK) See entire document	16
X	US,A, 2,207,926, Published 16 July 1940 (LANG) See entire document	17
X	US,A, 2,312,657, Published 2 March 1943 (LOCKE) See entire document	17
<p>[*] Special categories of cited documents ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search		Date of Mailing of this International Search Report
25 October 1988		08 DEC 1988
International Searching Authority		Signature of Authorized Officer
ISA/US		Philip R. Coe Philip R. Coe

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US,A, 4,210,004, Published 1 July 1980, (STOLL ET AL)	
A	US,A, 4,236,393, Published 2 December 1980, (KATZFEY)	
A	US,A, 4,485,509, Published 4 December 1984, (PELLERIN ET AL)	
A	GB,A, 2,055,903, Published 11 March 1981, (PELLERIN)	
A	IT,A, 460,561, Published 4 December 1950, (TEATINI)	

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

X	US,A, 2,300,690, Published 3 November 1942, (NEUMAN) See the entire document	19, 20
X	US,A, 3,103,802, Published 17 September 1963, (STREICH) See the entire document	19, 20
A	US,A, 10,796, Published 18 April 1854, (FAIRCHILD ET AL)	
A	US,A, 2,391,634, Published 25 December 1945, (LEWIS ET AL)	
A	US,A, 2,851,829, Published 16 September 1958, (MARTIN)	

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE ¹

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers _____, because they relate to subject matter ^{1,2} not required to be searched by this Authority, namely:
2. ☐ Claim numbers _____, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out ^{1,3}, specifically:
3. ☐ Claim numbers _____, because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING ²

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:
4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.